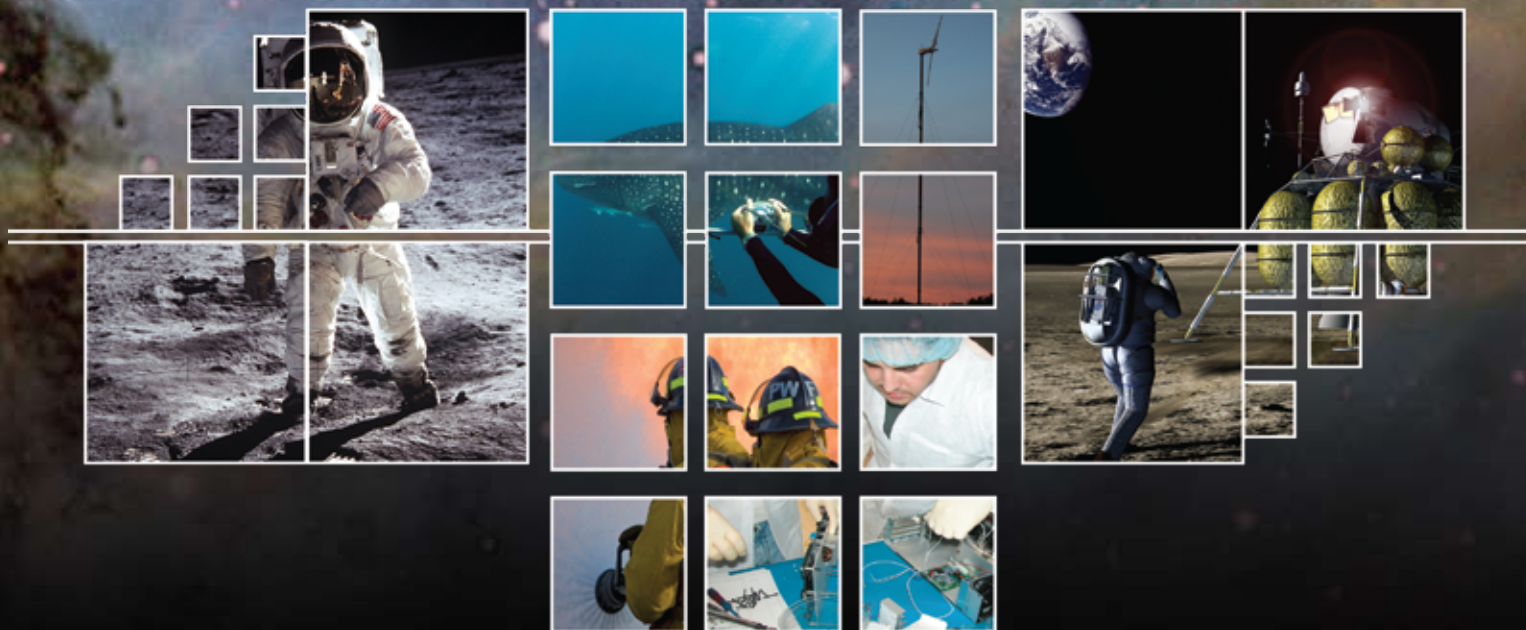


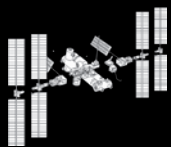
*Spinoff* 2009 highlights recent significant research and development activities across the Agency and the successful transfer of NASA technologies to the marketplace. This brochure summarizes the commercial technologies profiled in *Spinoff* 2009; the full text is available for download at <http://spinoff.nasa.gov>, and print copies can be requested by calling (301) 286-0561 or through [spinoff@sti.nasa.gov](mailto:spinoff@sti.nasa.gov).

A large graphic of the word "SPINOFF" in a bold, white, sans-serif font. Each letter is filled with a different image from the Apollo 16 mission. The 'S' shows a dark, rocky surface. The 'P' shows a yellow lunar rover. The 'I' shows a yellow lunar rover. The 'N' shows a yellow lunar rover. The 'O' shows a white lunar module. The 'F' shows an astronaut in a white spacesuit. The 'F' shows a yellow lunar rover. The background is a dark, starry space with a nebula.





International  
Space Station



Telescopes and  
Deep Space Exploration



Satellites and Imaging  
Technology



Space  
Transportation



Astronaut Life  
Support



Aeronautics  
Research



Innovative technologies from NASA's space and aeronautics missions (above) transfer as benefits to many sectors of society. Each benefit featured in *Spinoff* 2009 is listed with an icon that corresponds to the mission from which the technology originated. The numbered bullets correspond to points on the centerfold map, illustrating the geographic distribution of the featured companies.



## Health and Medicine

### 1 Image-Capture Devices Extend Medicine's Reach

Johnson Space Center, Henry Ford Hospital in Detroit, and Houston-based Wyle Laboratories collaborated on NASA's Advanced Diagnostic Ultrasound in Microgravity (ADUM) experiment, which developed revolutionary medical ultrasound diagnostic techniques for long-distance use. Mediphan, a Canadian company with U.S. operations in Springfield, New Jersey, drew on NASA expertise to create frame-grabber and data archiving technology that enables ultrasound users with minimal training to send diagnostic-quality ultrasound images and video to medical professionals via the Internet in near-real time—allowing patients as varied as professional athletes, Olympians, and mountain climbers to receive medical attention as soon as it is needed.



### 2 Medical Devices Assess, Treat Balance Disorders

Dr. Lewis Nashner's NASA-funded, pioneering work in the 1980s on balance assessment and rehabilitation led to the invention of the EquiTest computerized dynamic posturography system, used by Johnson Space Center to evaluate astronauts' balance upon their return to Earth's gravity. Commercialized by NeuroCom International Inc., of Clackamas, Oregon, the EquiTest has since been joined by a wide range of other balance-related medical devices and options. NeuroCom now has over 2,000 systems in use around the world in a variety of medical fields, including neurology, geriatrics, orthopedics, and sports medicine.



### 3 NASA Bioreactors Advance Disease Treatments

Houston-based biotechnology firm Regenotech Inc. acquired the licenses for NASA bioreactor technology from Johnson Space Center. The NASA bioreactor, which allows for the rapid cultivation of healthy cells in simulated weightlessness, is now the foundation of Regenotech's thriving intellectual property business that is providing researchers with the tools to make adult stem cell therapy—a potential source of treatment for conditions like heart disease, diabetes, and sickle cell anemia—viable for the public.



### 4 Robotics Algorithms Provide Nutritional Guidelines

Using robotics expertise gained while working as an engineer for a major telerobotics program funded by NASA Headquarters, Joe Graves founded a unique, online nutrition company called Vitabot, based in Beltsville, Maryland. Making use of some of the same concepts and style of algorithms Graves developed for NASA's Ranger Neutral Buoyancy Vehicle robot, Vitabot helps users set health goals, plan balanced meals, and lose weight through proper nutrition. Available through corporate wellness programs and health clubs, Vitabot now has nearly 1,000 company clients and has experienced over 1,500-percent growth in the health club industry—as its users have been shedding pounds through healthy eating.





### 5 'Anti-Gravity' Treadmills Speed Rehabilitation

A former Ames Research Center engineer, Dr. Robert Whalen, invented a treadmill that he licensed to a Menlo Park, California, company, Alter-G Inc. The company's G-Trainer is an enclosed treadmill that uses air pressure to help patients feel up to 80-percent lighter, easing discomfort during rehabilitation. A patient desiring more weightlessness during a workout can simply press a button and the air pressure increases, lifting the body and reducing strain and impact. The U.S. Food and Drug Administration cleared the G-Trainer for medical use in January 2008, and researchers are now assessing the G-Trainer's effectiveness in aiding patients with various neurological or musculoskeletal conditions.



### 6 Crew Management Processes Revitalize Patient Care

In 2005, two physicians, former NASA astronauts, created LifeWings Partners LLC, in Memphis, Tennessee, and began using Crew Resource Management (CRM) techniques developed at Ames Research Center in the 1970s to help improve safety and efficiency at hospitals. According to the company, when hospitals follow the LifeWings training, they can see major improvements in a number of areas, including efficiency, employee satisfaction, operating room turnaround, patient advocacy, and overall patient outcomes. LifeWings has brought its CRM training to over 90 health care organizations, and annual sales have remained close to \$3 million since 2007.



### 7 Hubble Systems Optimize Busy Hospital Schedules

Don Rosenthal, a former Ames Research Center computer scientist who helped design the Hubble Space Telescope's scheduling software, co-founded Allocade Inc., of Menlo Park, California, in 2004. Allocade's OnCue software helps hospitals reclaim unused capacity and optimize constantly changing schedules for imaging procedures. After starting to use the software, one medical center soon reported noticeable improvements in efficiency, including a 12-percent increase in procedure volume, 35-percent reduction in staff overtime, and significant reductions in backlog and technician phone time. Allocade now offers versions for outpatient and inpatient magnetic resonance imaging (MRI), ultrasound, interventional radiology, nuclear medicine, positron emission tomography (PET), radiography, radiography-fluoroscopy, and mammography.



### 8 Web-Based Programs Assess Cognitive Fitness

The National Space Biomedical Research Institute, based in Houston and funded by NASA, began funding research for Harvard University researchers to design Palm software to help astronauts monitor and assess their cognitive functioning. The MiniCog Rapid Assessment Battery (MRAB) was licensed by the Criteria Corporation in Los Angeles and adapted for Web-based employment testing. The test battery assesses nine different cognitive functions and can gauge the effect of stress-related deficits, such as fatigue, on various tasks. The MRAB can be used not only for pre-employment testing but also for repeat administrations to measure day-to-day job readiness in professions where alertness is critical.





## 9 Electrolyte Concentrates Treat Dehydration

Wellness Brands Inc., of Boulder, Colorado, exclusively licensed a unique electrolyte concentrate formula developed by Ames Research Center to treat and prevent dehydration in astronauts returning to Earth. Marketed as The Right Stuff, the company's NASA-derived formula is an ideal measure for athletes looking to combat dehydration and boost performance. Wellness Brands also plans to expand with products that make use of the formula's effective hydration properties to help treat conditions including heat stroke, altitude sickness, jet lag, and disease.



## Transportation

### 10 Tools Lighten Designs, Maintain Structural Integrity

Collier Research Corporation, of Hampton, Virginia, licensed software developed at Langley Research Center to reduce design weight through the use of composite materials. The first license of NASA-developed software, it has now been used in everything from designing next-generation cargo containers, to airframes, rocket engines, ship hulls, and train bodies. The company now has sales of the NASA-derived software topping \$4 million a year and has recently received several Small Business Innovation Research (SBIR) contracts to apply its software to nearly all aspects of the new Orion crew capsule design.



### 11 Insulating Foams Save Money, Increase Safety

Scientists at Langley Research Center created polyimide foam insulation for reusable cryogenic propellant tanks on the space shuttle. Meanwhile, a small Hialeah, Florida-based business, PolyuMAC Inc., was looking for advanced foams to use in the customized manufacturing of acoustical and thermal insulation. The company contacted NASA, licensed the material, and then the original inventors worked with the company's engineers to make a new material that was better for both parties. The new version, a high performance, flame retardant, flexible polyimide foam, is used for insulating NASA cryogenic propellant tanks and shows promise for use on watercraft, aircraft, spacecraft, electronics and electrical products, automobiles and automotive products, recreation equipment, and building and construction materials.



### 12 Polyimide Resins Resist Extreme Temperatures

To combat the high temperatures in aerospace applications, Dr. Ruth Pater of Langley Research Center developed RP-46, a polyimide resin capable of withstanding the most brutal temperatures while still being lightweight (less than half the weight of aluminum), chemical and moisture resistant, strong, and flexible. Designed as an environmentally friendly alternative to other high-temperature resins, the RP-46 polyimide resin system was awarded a 1992 "R&D 100" award, named a 2001 "NASA Technology of the Year," and later, due to its success as a spinoff technology, 2004 "NASA Commercial Invention of the Year." Unitech LLC, of Hampton, Virginia, received a nonexclusive license from NASA for commercialization of the material, and it is now in widespread industrial use.





### 13 Sensors Locate Radio Interference

After receiving a NASA SBIR contract from Kennedy Space Center, Soneticom Inc., based in West Melbourne, Florida, created algorithms for time difference of arrival and radio interferometry, which it used in its Lynx Location System (LLS) to locate electromagnetic interference that can disrupt radio communications. Soneticom is collaborating with the Federal Aviation Administration (FAA) to install and test the LLS at its field test center in New Jersey in preparation for deploying the LLS at commercial airports. The software collects data from each sensor in order to compute the location of the interfering emitter.



### 14 Surface Operations Systems Improve Airport Efficiency

With SBIR contracts from Ames Research Center, Mosaic ATM Inc., of Leesburg, Virginia, created software to analyze surface operations at airports. Surface surveillance systems, which report locations every second for thousands of air and ground vehicles, generate massive amounts of data, making gathering and analyzing this information difficult. Mosaic's Surface Operations Data Analysis and Adaptation (SODAA) tool is an off-line support tool that can analyze how well the airport surface operation is working and can help redesign procedures to improve operations. SODAA helps researchers pinpoint trends and correlations in vast amounts of recorded airport operations data.



### 15 Nontoxic Resins Advance Aerospace Manufacturing

The 2008 "NASA Commercial Invention of the Year," PETI-330, is a polyimide matrix resin that performs well at high temperatures and is easily processed into composites in a simple, short-curing cycle. Invented by scientists at Langley Research Center, PETI-330 is now licensed to Ube Industries Ltd., based in Japan with its American headquarters in New York. In addition to being durable and lightweight, the resin is also nontoxic, which makes it safe for workers to handle. PETI-330 was created specifically for heat-resistant composites formed with resin transfer molding and resin infusion, which formerly could only be used with low-temperature resin systems.



## Public Safety

### 16 Sensors Provide Early Warning of Biological Threats

Early Warning Inc., of Troy, New York, licensed powerful biosensor technology from Ames Research Center. Incorporating carbon nanotubes tipped with single strands of nucleic acid from waterborne pathogens, the sensor can detect even minute amounts of targeted, disease-causing bacteria, viruses, and parasites. Early Warning features the NASA biosensor in its water analyzer, which can alert organizations to potential biological hazards in water used for agriculture, food and beverages, showers, and at beaches and lakes—within hours instead of the days required by conventional laboratory methods.





### 17 Robots Save Soldiers' Lives Overseas

Marshall Space Flight Center mobile communications platform designs for future lunar missions led to improvements to fleets of tactical robots now being deployed by the U.S. Army. The Multi-function Agile Remote Control Robot (MARCbot) helps soldiers search out and identify improvised explosive devices. NASA used the MARCbot to test its mobile communications platform, and in working with it, made the robot faster while adding capabilities—upgrading to a digital camera, encrypting the controllers and video transmission, as well as increasing the range and adding communications abilities. They also simplified the design, providing more plug-and-play sensors and replacing some of the complex electronics with more trouble-free, low-cost components. Applied Geo Technologies Inc., a tribally-owned corporation in Choctaw, Mississippi, was given the task of manufacturing the modified robots. The company is now producing 40 units per month, 300 of which have already been deployed overseas.



### 18 Apollo-Era Life Rafts Save Hundreds of Sailors

To keep life rafts holding astronauts and frogmen from capsizing from the downdraft of rescue helicopters after Apollo-era splashdown landings, engineers at NASA's Johnson Space Center designed and patented a self-righting life raft capable of resisting tipping in choppy seas and fierce winds. Givens Marine Survival Co. Inc., of Tiverton, Rhode Island, patented this invention and now manufactures and markets the rescue rafts—under the name Givens Buoy Life Raft—in a variety of sizes and models for everything from sailboats to larger ocean-going vessels. To date, Givens has sold several thousand of the ballasted, inflatable life rafts, and this space-age technology is credited with saving the lives of over 450 sailors.



### 19 Circuits Enhance Scientific Instruments and Safety Devices

In 1996, Thomas Crowe and William Bishop founded Virginia Diodes Inc. (VDI), based in Charlottesville, Virginia. VDI now has over 30 full-time employees and grows 30 percent per year, growth Crowe credits to its terahertz products developed under SBIR contracts with Goddard Space Flight Center. Because of the unique characteristics of terahertz radiation—such as its ability to image hidden items and to detect and identify a wide range of chemicals—there is a growing demand for terahertz components. Applications include security imaging systems, hazardous chemical and biological-agent detectors, plasma diagnostic instruments, and industrial process monitors. The company has over 200 customers in over two dozen countries.



### 20 Tough Textiles Protect Payloads and Public Safety Officers

In order to create the Mars Pathfinder's mission-critical airbags in the 1990s, NASA's Jet Propulsion Laboratory collaborated with New Ipswich, New Hampshire's Warwick Mills Inc. to weave multilayer textiles for the airbags for both Pathfinder and the Mars Exploration Rovers. Warwick Mills applied techniques from the collaboration to its puncture- and impact-resistant TurtleSkin product line. The company's metal flex armor (MFA) vests offer stab protection comparable with rigid steel plates, and over 50,000 of the vests have sold. The SoftPlate body armor offers protection from handgun bullets, and like the MFA, is designed to be more comfortable than rigid vests. International public safety and military customers are now benefiting from the TurtleSkin products.







## Consumer, Home, and Recreation

### 21 Forecasting Tools Point to Fishing Hotspots

Private weather forecaster WorldWinds Inc., of Slidell, Louisiana, has employed satellite-gathered oceanic data from Marshall Space Flight Center to create a service that is every fishing enthusiast's dream. The company's FishBytes system uses information about sea surface temperature and chlorophyll levels to forecast favorable conditions for certain fish populations. Transmitting the data to satellite radio subscribers, FishBytes—with about 8,500 subscribers so far—provides maps that guide anglers to the areas where they are most likely to make their favorite catch.



### 22 Air Purifiers Eliminate Pathogens, Preserve Food

NASA-funded researchers produced an ethylene reduction device for a plant growth unit. KES Science and Technology Inc., a Kennesaw, Georgia-based company specializing in sustaining perishable foods, licensed the ethylene scrubbing technology. KES partnered with Akida Holdings, of Jacksonville, Florida, which now markets the NASA-developed technology as AiroCide. According to the company, it is the only air purifier that completely destroys airborne bacteria, mold, fungi, mycotoxins, viruses, volatile organic compounds (like ethylene), and odors. What's more, the devices have no filters that need changing and produce no harmful byproducts, such as the ozone created by some filtration systems.



### 23 Fabrics Protect Sensitive Skin from UV Rays

Late Johnson Space Center engineer Dr. Robert Dotts headed a team to develop cool suits for children suffering from life-threatening sun sensitivities. Dotts hoped to develop ultraviolet-blocking technology in a fabric that—unlike in a bulky space suit—could remain comfortable, light, and breathable in the sun and heat. The team worked with the Solar Protective Factory Inc. (SPF), of Madison, Wisconsin, to design ultraviolet-blocking cool suits, which protect sun-sensitive patients and enable them to experience life outdoors safely. Using knowledge gained during the NASA collaboration, SPF created an entire line of ultraviolet-blocking apparel.



### 24 Phase Change Fabrics Control Temperature

Originally featured in *Spinoff* 1997, Outlast Technologies Inc. (formerly Gateway Technologies Inc.) has built its entire product line on microencapsulated phase change materials developed in SBIR contracts with Johnson Space Center after initial development for the U.S. Air Force. The Boulder, Colorado-based company acquired the exclusive patent rights and now integrates these materials into textiles or onto finished apparel, providing temperature regulation in bedding materials and a full line of apparel for both ordinary and extreme conditions.





### 25 Tiny Devices Project Sharp, Colorful Images

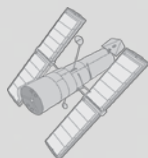
Displaytech Inc., based in Longmont, Colorado, and recently acquired by Micron Technology Inc., of Boise, Idaho, first received an SBIR contract in 1993 from Johnson Space Center to develop tiny, electronic, color displays, called microdisplays. Displaytech has since sold over 20 million microdisplays and was ranked one of the fastest growing technology companies by Deloitte and Touche in 2005. Customers currently incorporate the microdisplays in tiny pico projectors, which weigh only a few ounces and attach to media players, cell phones, and other devices. The projectors can convert a digital image from the typical postage stamp size into a bright, clear, 4-foot-wide projection. The company believes sales of this type of pico projector may exceed \$1.1 billion within 5 years.



## Environmental and Agricultural Resources

### 26 Star-Mapping Tools Enable Tracking of Endangered Animals

Software programmer Jason Holmberg, of Portland, Oregon, partnered with a Goddard Space Flight Center astrophysicist to develop a method for tracking the elusive whale shark using the unique spot patterns on the fish's skin. Employing a star-mapping algorithm originally designed for the Hubble Space Telescope, Holmberg created a photograph database and pattern-matching system that can identify whale sharks by their spots and match images contributed to the database by photographers from around the world. The system has been adapted for tracking other rare and endangered animals, including polar bears and ocean sunfish.



### 27 Nanofiber Filters Eliminate Contaminants

With support from SBIR funding from Johnson Space Center, Argonide Corporation, of Sanford, Florida, tested and developed its proprietary nanofiber water filter media. Capable of removing more than 99.99 percent of dangerous particles like bacteria, viruses, and parasites, the media was incorporated into the company's commercial NanoCeram water filter, a 2002 "R&D 100" award winner and 2005 inductee into the Space Foundation's Space Technology Hall of Fame. In addition to its drinking water filters, Argonide now produces large-scale nanofiber filters used for industrial and municipal water purification.



### 28 Modeling Innovations Advance Wind Energy Industry

In 1981, Glenn Research Center scientist Dr. Larry Viterna developed a model that predicted certain elements of wind turbine performance with far greater accuracy than previous methods. The model was met with derision from others in the wind energy industry, but years later, Viterna discovered it had become the most widely used method of its kind, enabling significant wind energy technologies—like the fixed pitch turbines produced by manufacturers like Aerostar Inc., of Westport, Massachusetts—that are providing sustainable, climate friendly energy sources today.







### 29 Thermal Insulation Strips Conserve Energy

Flexible aerogel technology developed by Aspen Aerogels, of Northborough, Massachusetts, under SBIR contracts with Kennedy Space Center, is now being employed in a building insulation application by Tampa, Florida-based Acoustiblok Inc. The company's Thermablok flexible aerogel strips—easy-to-install and environmentally friendly—are applied to wall studs in buildings to break the thermal bridging between the interior and exterior walls, boosting the insulation factor by as much as 42 percent.



### 30 Satellite-Respondent Buoys Identify Ocean Debris

As part of its ocean-observing work, NASA partnered with NOAA and private industry to develop remote sensing technologies for protecting the seas of the North Pacific from derelict fishing gear. As part of this program, Airborne Technologies Inc. (ATI), of Wasilla, Alaska, developed a system using satellite-respondent buoys to monitor the convergence of currents in order to track high seas debris. ATI has now built over 900 of the buoys, and that original work has also led to the development of a prototype unmanned aircraft system and unique complementary software designed to process ocean images to detect debris fields.



### 31 Mobile Instruments Measure Atmospheric Pollutants

Under SBIR contracts from Glenn Research Center, Billerica, Massachusetts-based Aerodyne Research Inc. (ARI) has created spectrometers for use in mobile laboratories to study ground-based air pollution. ARI developed its tunable infrared laser differential absorption spectrometers to detect a range of more than 15 of the most important greenhouse gasses and air pollutants, including carbon dioxide, nitrogen dioxide, and methane. In addition to mobile measurements from van, aircraft, and ship platforms, ARI and its customers use the instruments to determine the magnitude of pollutant emissions. The company's products are currently in use in numerous climate change laboratories on five continents.



### 32 Cloud Imagers Offer New Details on Earth's Health

Boulder, Colorado-based Stratton Park Engineering Company Inc. (SPEC) has won numerous SBIR contracts to develop atmospheric instrumentation, including a Phase II SBIR from NASA's Jet Propulsion Laboratory for cloud particle imagers. The SPEC Cloud Particle Imager (CPI) has been installed on NASA's high-altitude research aircraft and has been sold to universities and agencies around the world. Mounted to airplane exteriors, the CPI system captures images of cloud particles, enabling further analysis for climate predictions and research.





### 33 Antennas Lower Cost of Satellite Access

SeaSpace Corporation, of Poway, California, worked with NASA's Jet Propulsion Laboratory under two SBIR contracts to reduce the cost of satellite ground tracking. The resulting hardware and software not only complement NASA's remote sensing capabilities but also benefit the greater research community, tracking low-Earth orbit satellites for remote sensing; science; communications; and telemetry, tracking, and command applications, providing true full hemispherical coverage. The company's ground-based receivers are now in continuous operation on all seven continents, with customers including aerospace and defense clients, the scientific community, national and local weather services, the research industry, and public safety organizations.



### 34 Feature Detection Systems Enhance Satellite Imagery

Supported by SBIR contracts with Stennis Space Center, Geospatial Data Analysis Corporation, of State College, Pennsylvania, invented software for automatically identifying clouds in satellite imagery without the use of thermal data—an important development for satellites that forgo expensive thermal imaging equipment. The company's software provides highly accurate cloud identification for private remote sensing imagery firms, and the technology's feature detection capabilities are also being applied to a range of land features, helping researchers study the effects of population growth and climate change on crop field acreage, flood zones, and plant cover.



### 35 Chlorophyll Meters Aid Plant Nutrient Management

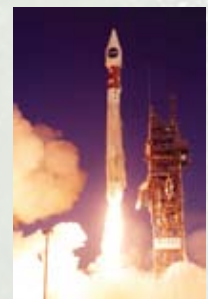
Spectrum Technologies, headquartered in Plainfield, Illinois, licensed a hand-held plant chlorophyll meter developed from Stennis Space Center's research on satellite sensors. The meter measures light to determine a plant's chlorophyll content—a strong indicator of plant health. Spectrum improved the NASA technology and commercialized it as its FieldScout meters. Growers and agricultural researchers can now use the meters to determine the nutrient needs of crops like wheat, rice, cotton, and corn. The meters are also effective nutrient management tools for turf grass, making them ideal for the maintenance of golf courses and athletic fields.



## Computer Technology

### 36 Telemetry Boards Interpret Rocket, Airplane Engine Data

Through a Space Act Agreement with Kennedy Space Center, telemetry innovator Ulyssix Technologies Inc., of Frederick, Maryland, is furthering its long-standing NASA relationship and expanding its commercial telemetry expertise. Ulyssix's telemetry hardware—like its TarsusPCM processing board used by Kennedy to gather and translate data on rocket and space shuttle launches—is being employed for jet engine and airplane testing and development, as well as ground support equipment for satellites. The hardware may also become a part of private space industry projects, all while still supporting NASA efforts, such as testing for the Constellation Program.







### **37 Programs Automate Complex Operations Monitoring**

Command and Control Technologies Corporation (CCT), of Titusville, Florida, licensed software created to automate mission-critical applications at the Kennedy Space Center launch complex. The company now applies the same management technologies created for NASA launches to other complex yet critical operations: weapons test ranges, borders protection, and large industrial processes, like monitoring and managing power plants.



### **38 Software Tools Streamline Project Management**

Three innovative software inventions from Ames Research Center (NETMARK, Program Management Tool, and Query-Based Document Management) are finding their way into NASA missions as well as industry applications. The three software tools have been bundled together for the purpose of executing a non-exclusive patent license, and JumpStart Solutions LLC, of Cave Creek, Arizona, licensed them for use in its PanOptica product suite. The company now offers customers a cost-effective, scalable, easy-to-use suite of tools to manage projects, portfolios, and knowledge bases and documents.



### **39 Modeling Languages Refine Vehicle Design**

Cincinnati, Ohio's TechnoSoft Inc. is a leading provider of object-oriented modeling and simulation technology used for commercial and defense applications. With funding from SBIR contracts issued by Langley Research Center, the company continued development on its adaptive modeling language, or AML, originally created for the U.S. Air Force. TechnoSoft then created what is now known as its Integrated Design and Engineering Analysis Environment, or IDEA, which can be used to design a variety of vehicles and machinery. IDEA's customers include clients in green industries, such as designers for power plant exhaust filtration systems and wind turbines.



### **40 Radio Relays Improve Wireless Products**

Signal Hill, California-based XCOM Wireless Inc. developed radio frequency microelectromechanical systems (RF MEMS) relays with a Phase II SBIR contract through NASA's Jet Propulsion Laboratory. In order to improve satellite communication systems, XCOM produced wireless RF MEMS relays and tunable capacitors that use metal-to-metal contact and have the potential to outperform most semiconductor technologies while using less power. These relays are used in high-frequency test equipment and instrumentation, where increased speed can mean significant cost savings. Applications now also include mainstream wireless applications and greatly improved tactical radios.



## **Industrial Productivity**



### **41 Advanced Sensors Boost Optical Communication, Imaging**

Brooklyn, New York-based Amplification Technologies Inc. (ATI) employed SBIR funding from NASA's Jet Propulsion Laboratory to forward the company's solid-state photomultiplier technology. Under the SBIRs, ATI developed a small, energy-efficient, extremely high-gain sensor capable of detecting light down to single photons in the near infrared wavelength range. The company has commercialized this technology in the form of its NIRDAPD photomultiplier, ideal for use in free space optical communications, lidar and ladar, night vision goggles, and other light sensing applications.

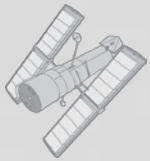






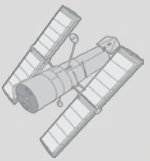
#### **42 Tensile Fabrics Enhance Architecture Around the World**

Using a remarkable fabric originally developed to protect Apollo astronauts, Birdair Inc., of Amherst, New York, has crafted highly durable, safe, environmentally friendly, and architecturally stunning tensile membrane roofs for over 900 landmark structures around the world. Travelers in airports, sports fans at stadiums, and shoppers in malls have all experienced the benefits of the Teflon-coated fiberglass fabric that has enabled Birdair to grow from a small company established in its founder's kitchen in 1956 to a multimillion-dollar specialty contractor today.



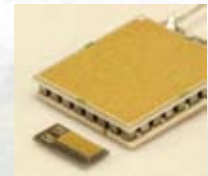
#### **43 Robust Light Filters Support Powerful Imaging Devices**

Infrared (IR) light filters developed by Lake Shore Cryotronics Inc., of Westerville, Ohio—using SBIR funding from NASA's Jet Propulsion Laboratory and Langley Research Center—employ porous silicon and metal mesh technology to provide optical filtration even at the ultra-low temperatures required by many IR sensors. With applications in the astronomy community, Lake Shore's SBIR-developed filters are also promising tools for use in terahertz imaging, the next wave of technology for applications like medical imaging, the study of fragile artworks, and airport security.



#### **44 Thermoelectric Devices Cool, Power Electronics**

Nextreme Thermal Solutions Inc., based in Research Triangle Park, North Carolina, licensed thermoelectric technology from NASA's Jet Propulsion Laboratory. This has allowed the company to develop cutting edge, thin film thermoelectric coolers that effectively remove heat generated by increasingly powerful and tightly packed microchip components. These solid-state coolers are ideal solutions for applications like microprocessors, laser diodes, LEDs, and even potentially for cooling the human body. Nextreme's NASA-enabled technology has also resulted in embedded thermoelectric generators capable of powering technologies like medical implants and wireless sensor networks.



#### **45 Innovative Tools Advance Revolutionary Weld Technique**

Nova-Tech Engineering LLC, of Lynnwood, Washington, received a co-exclusive license for Marshall Space Flight Center technology that significantly improves an advanced welding technique called friction stir welding (FSW). The technique creates a superior weld to traditional fusion methods, but leaves a hole when the welding machine's rotating pin, which creates the weld, exits the weld joint. It also has difficulty welding materials of tapering thicknesses. Marshall invented an auto retractable pin tool that solves these problems. The innovation now allows Nova-Tech's FSW machines to perform effective welds for offshore drilling rig piping, armor plating, and rocket manufacturing.





#### **46 Methods Reduce Cost, Enhance Quality of Nanotubes**

SBIR contracts with Johnson Space Center supported the development and demonstration of a nanotube production method pioneered by SouthWest NanoTechnologies Inc. (SWeNT), of Norman, Oklahoma. SWeNT's scalable, efficient process results in mass-produced nanotubes that are customizable to client needs and more pure than those created by other methods. These enhanced manufacturing capabilities may soon allow for nanotube-enabled technologies like advanced body armor, ultra-conductive wiring, printable electronics, and green innovations like more affordable solar panels and low-energy, solid-state lighting products. SWeNT's NASA-supported process has allowed the company to increase production a hundredfold while lowering cost tenfold.



#### **47 Gauging Systems Monitor Cryogenic Liquids**

With SBIR awards from Kennedy Space Center, Sierra Lobo Inc. (SLI), based in Fremont, Ohio, developed the Cryo-Tracker Mass Gauging System (Cryo-Tracker MGS). The Cryo-Tracker MGS is a three-part system that integrates the use of software, electronics, and the "R&D 100" award-winning Cryo-Tracker probe. SLI is marketing the Cryo-Tracker MGS to companies that use and store cryogenics, including medical organizations, metals processors, and semiconductor manufacturers, which use the Cryo-Tracker MGS to monitor mass, liquid levels, temperature, and pressure for stored liquid helium, hydrogen, nitrogen, or oxygen. SLI began with only 9 employees in 1993, and now has an ISO 9001:2008 registration and over 370 employees.



#### **48 Voltage Sensors Monitor Harmful Static**

A tiny sensor, small enough to be worn on clothing, now monitors voltage changes near sensitive instruments after being created to alert Space Agency workers to dangerous static buildup near fuel operations and avionics. San Diego's QUASAR Federal Systems Inc. received an SBIR contract from Kennedy Space Center to develop its remote voltage sensor (RVS), a dime-sized electrometer designed to measure triboelectric changes in the environment. One of the unique qualities of the RVS is that it can detect static at greater distances than previous devices, measuring voltage changes from a few centimeters to a few meters away, due to its much-improved sensitivity.



#### **49 Compact Instruments Measure Heat Potential**

Based in Huntsville, Alabama, AZ Technology Inc. is a woman- and veteran-owned business that offers expertise in electromechanical-optical design and advanced coatings. AZ Technology has received eight SBIR contracts with Marshall Space Flight Center for the development of spectral reflectometers and the measurement of surface thermal properties. The company uses a variety of measurement services and instruments, including the Spectrafire, a compact spectral emissometer it used to assist General Electric Company with the design of its award-winning Giraffe Warmer for neonatal intensive care units.







### Health and Medicine

- 1 Image-Capture Devices Extend Medicine's Reach (NJ)
- 2 Medical Devices Assess, Treat Balance Disorders (OR)
- 3 NASA Bioreactors Advance Disease Treatments (TX)
- 4 Robotics Algorithms Provide Nutritional Guidelines (MD)
- 5 'Anti-Gravity' Treadmills Speed Rehabilitation (CA)
- 6 Crew Management Processes Revitalize Patient Care (TN)
- 7 Hubble Systems Optimize Busy Hospital Schedules (CA)
- 8 Web-Based Programs Assess Cognitive Fitness (CA)
- 9 Electrolyte Concentrates Treat Dehydration (CO)



### Transportation

- 10 Tools Lighten Designs, Maintain Structural Integrity (VA)
- 11 Insulating Foams Save Money, Increase Safety (FL)
- 12 Polyimide Resins Resist Extreme Temperatures (VA)
- 13 Sensors Locate Radio Interference (FL)
- 14 Surface Operations Systems Improve Airport Efficiency (VA)
- 15 Nontoxic Resins Advance Aerospace Manufacturing (NY)



### Public Safety

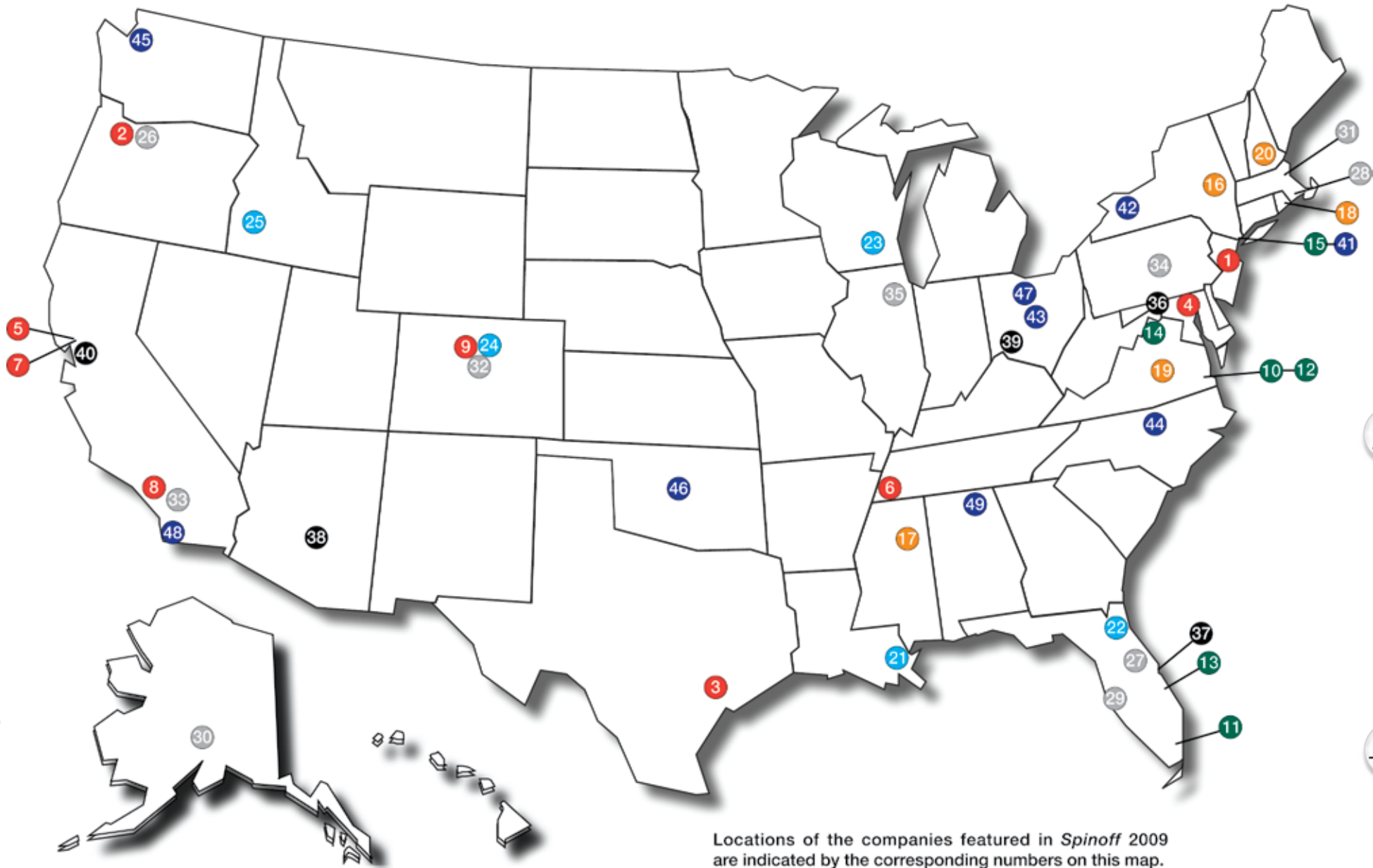
- 16 Sensors Provide Early Warning of Biological Threats (NY)
- 17 Robots Save Soldiers' Lives Overseas (MS)
- 18 Apollo-Era Life Rafts Save Hundreds of Sailors (RI)
- 19 Circuits Enhance Scientific Instruments and Safety Devices (VA)
- 20 Tough Textiles Protect Payloads and Public Safety Officers (NH)



### Consumer, Home, and Recreation

- 21 Forecasting Tools Point to Fishing Hotspots (LA)
- 22 Air Purifiers Eliminate Pathogens, Preserve Food (FL)
- 23 Fabrics Protect Sensitive Skin from UV Rays (WI)
- 24 Phase Change Fabrics Control Temperature (CO)
- 25 Tiny Devices Project Sharp, Colorful Images (ID)

# NASA Technologies Benefiting Society



### Environmental and Agricultural Resources

- 26 Star-Mapping Tools Enable Tracking of Endangered Animals (OR)
- 27 Nanofiber Filters Eliminate Contaminants (FL)
- 28 Modeling Innovations Advance Wind Energy Industry (MA)
- 29 Thermal Insulation Strips Conserve Energy (FL)
- 30 Satellite-Respondent Buoys Identify Ocean Debris (AK)
- 31 Mobile Instruments Measure Atmospheric Pollutants (MA)
- 32 Cloud Imagers Offer New Details on Earth's Health (CO)
- 33 Antennas Lower Cost of Satellite Access (CA)
- 34 Feature Detection Systems Enhance Satellite Imagery (PA)
- 35 Chlorophyll Meters Aid Plant Nutrient Management (IL)



### Computer Technology

- 36 Telemetry Boards Interpret Rocket, Airplane Engine Data (MD)
- 37 Programs Automate Complex Operations Monitoring (FL)
- 38 Software Tools Streamline Project Management (AZ)
- 39 Modeling Languages Refine Vehicle Design (OH)
- 40 Radio Relays Improve Wireless Products (CA)



### Industrial Productivity

- 41 Advanced Sensors Boost Optical Communication, Imaging (NY)
- 42 Tensile Fabrics Enhance Architecture Around the World (NY)
- 43 Robust Light Filters Support Powerful Imaging Devices (OH)
- 44 Thermoelectric Devices Cool, Power Electronics (NC)
- 45 Innovative Tools Advance Revolutionary Weld Technique (WA)
- 46 Methods Reduce Cost, Enhance Quality of Nanotubes (OK)
- 47 Gauging Systems Monitor Cryogenic Liquids (OH)
- 48 Voltage Sensors Monitor Harmful Static (CA)
- 49 Compact Instruments Measure Heat Potential (AL)

The Nation's investment in NASA's aerospace research has brought practical benefits back to Earth in the form of commercial products and services in the fields of health and medicine; transportation; public safety; consumer, home, and recreation goods; environmental and agricultural resources; computer technology; and industrial productivity. *Spinoff*, NASA's premier annual publication, features these commercialized technologies. Since its inception in 1976, *Spinoff* has profiled NASA-derived products from companies across the Nation. An online archive of all stories from the first issue of *Spinoff* to the latest is available in the *Spinoff* database at [www.sti.nasa.gov/spinoff/database](http://www.sti.nasa.gov/spinoff/database).

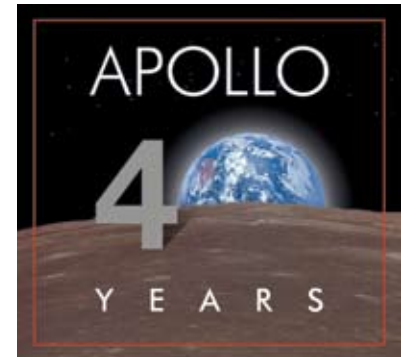
Visit the Innovative Partnerships Program at <http://www.ipp.nasa.gov>.



# Innovative Partnerships Program

The Innovative Partnerships Program (IPP) facilitates the transfer of new technologies to the private sector. It is also the organization within NASA responsible for providing needed technology and capabilities to NASA's Mission Directorates, programs, and projects through investments and partnerships with industry, academia, government agencies, and national laboratories. IPP has offices at each of NASA's 10 field centers, and elements that include: Technology Infusion, which manages the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs and the IPP Seed Fund; the Innovation Incubator, which includes the Centennial Challenges and new efforts with the emerging commercial space sector; and Partnership Development, which includes intellectual property management and technology transfer. In FY 2009:

- NASA entered into over 250 Space Act Agreements with private and other external entities for development of dual-use technology targeted to Mission Directorate technology needs.
- IPP-sponsored technologies achieved over 380 technology advances, and more than 140 infusion successes benefiting NASA programs and projects.
- IPP worked with ESMD to select and fund 9 Seed Fund partnerships for research in support of the International Space Station (ISS). These partnerships span 12 states and include: 9 small to medium sized businesses, 4 large corporations, 2 universities, 7 NASA Centers and 1 other federal laboratory. The partnerships leverage \$1.9 million from ISS research into \$6 million of effort through partnership contributions.
- IPP facilitated the signing of technology license agreements putting over 80 NASA technologies to work and also facilitated about 950 Software Use Agreements.
- IPP facilitated the reporting of more than 1400 new invention disclosures from across NASA. As a result of IPP's efforts, over 90 NASA patent applications were filed and 188 patents awarded in 2009. Revenues realized from licenses of NASA-sponsored technologies exceeded \$2.2M in 2009.
- IPP completed five Centennial Challenge events during 2009 and awarded \$3.65 million in combined prize money to eight winning teams at four of the competitions.
- Numerous NASA-derived technologies continued to yield direct public benefit in addition to their intended NASA application, including 49 of the top recent examples that are highlighted in this 2009 edition of *Spinoff*.



## Spinoff (spin'ôf') -noun.

1. A commercialized product incorporating NASA technology or "know how" which benefits the public. Qualifying technologies include:
  - Products or processes designed for NASA use, to NASA specifications, and then commercialized
  - Components or processes involving NASA technology incorporated into a commercial product, employed in the manufacturing of a product, or used to modify the design of an existing product
  - Products or processes to which NASA laboratory personnel made significant contributions, including the use of NASA facilities for testing purposes
  - Successful entrepreneurial endeavors by ex-NASA employees whose technical expertise was developed while employed by NASA
  - Products or processes commercialized as the result of a NASA patent license or waiver
  - Commercial products or processes developed as a result of the Small Business Innovation Research or Small Business Technology Transfer programs
2. NASA's premier annual publication, featuring successfully commercialized NASA technologies.

National Aeronautics and Space Administration

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